

# **PART 1**

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## **Current Information on the Health Consequences of Smoking**

## Introduction

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In January 1964, an Advisory Committee appointed by the Surgeon General of the Public Health Service issued its report (15) on the relationship between smoking and health.\* The conclusions of that Committee were summed up in the sentence: "Cigarette smoking is a health hazard of sufficient importance in the United States to warrant appropriate remedial action."

In the 3½ years since the publication of that report, an unprecedented amount of pertinent research has been completed, continued, or initiated in this country and abroad under the sponsorship of governments, universities, industry groups, and other entities. This research has been reviewed and no evidence has been revealed which brings into question the conclusions of the 1964 report. On the contrary, the research studies published since 1964 have strengthened those conclusions and have extended in some important respects our knowledge of the health consequences of smoking.

The present state of knowledge of these health consequences can, in the judgment of the Public Health Service, be summarized as follows:

1. Cigarette smokers have substantially higher rates of death and disability than their nonsmoking counterparts in the population. This means that cigarette smokers tend to die at earlier ages and experience more days of disability than comparable nonsmokers.
2. A substantial portion of earlier deaths and excess disability would not have occurred if those affected had never smoked.
3. If it were not for cigarette smoking, practically none of the earlier deaths from lung cancer would have occurred; nor a substantial portion of the earlier deaths from chronic bronchopulmonary diseases (commonly diagnosed as chronic bronchitis or pulmonary emphysema or both); nor a portion of the earlier deaths of cardiovascular origin. Excess disability from chronic pulmonary and cardiovascular diseases would also be less.

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\*"Smoking and Health. Report of the Advisory Committee to the Surgeon General of the Public Health Service." It is frequently referred to in this manuscript as "the Surgeon General's 1964 Report."

4. Cessation or appreciable reduction of cigarette smoking could delay or avert a substantial portion of deaths which occur from lung cancer, a substantial portion of the earlier deaths and excess disability from chronic bronchopulmonary diseases, and a portion of the earlier deaths and excess disability of cardiovascular origin.

## NATURE OF RECENT RESEARCH FINDINGS

Since the Surgeon General's Report was published in January 1964, there has been a proliferation of additional studies and reports on smoking research. In the 12 years preceding that report, some 3,000 articles were published reporting research; since 1964, there have been more than 2,000 additional studies.

These studies have helped to clarify the role that age plays in the relationship of smoking to health; the similarities and differences in the ways in which men and women are affected by smoking; and the influences and effects of stopping smoking, particularly in the case of lung cancer where there is significant data to show that sharp reductions in lung cancer deaths follow closely reductions in cigarette smoking. The studies also suggest the importance of a variety of measures of exposure; add substantial new information on the magnitude of the morbidity problem associated with smoking; and provide more adequate data upon which to base estimates of the magnitude of the mortality problem.

Historically, concern about the effects of smoking began with observations of the extremely high frequency with which lung cancer patients were identified as cigarette smokers. These observations took on a fuller meaning with the first publication of the prospective studies in 1954 when higher overall death rates among cigarette smokers were identified. The rates were found to exceed the difference that could be accounted for by lung cancer alone. Until that time, the possibility remained that although more cigarette smokers appeared to suffer from lung cancer, if there were no significant excess overall mortality, some other cause or causes of mortality would have had to be underrepresented among cigarette smokers.

The Surgeon General's 1964 Report concluded that cigarette smokers do have higher death rates than their nonsmoking counterparts. This has changed the emphasis of the present problem away from the question "does cigarette smoking cause disease?" to the more precise questions of:

1. How much mortality and excess disability are associated with smoking?

2. How much of this early mortality and excess disability would not have occurred if people had not taken up cigarette smoking?

3. How much of this early mortality and excess disability could be averted by the cessation or reduction of cigarette smoking?

4. What are the biomechanisms whereby these effects take place and what are the critical factors in these mechanisms?

To answer these questions one must not only study the details of the relationship of overall mortality with cigarette smoking, one must also turn to the specific causes of death and disability and to other kinds of evidence.

The research carried on since 1964 is of three principal varieties: Epidemiological studies, especially those which involve surveys of large portions of the population; a health survey which has revealed new information about the relation between smoking and illness; and a vast amount of experimental, clinical, pathological, and behavioral research which adds to the understanding of the precise ways in which smoking affects the body, plus other closely related or peripheral information.

In the area of morbidity or illness, the primary addition to our knowledge is from "Cigarette Smoking and Health Characteristics," a report (16) of the National Center for Health Statistics on the frequency of illness among smokers and nonsmokers in a large probability sample of the U.S. population. Regarding epidemiological data, new reports from four of the major population studies have been published since 1964:

1. The Dorn study of smoking and mortality among U.S. veterans (13).

2. Hammond's study on smoking in relation to the death rates of 1 million men and women in 25 States (11).

3. The Doll and Hill study on the mortality of British physicians in relation to smoking (8,9,10).

4. A Canadian Smoking and Health Study of Canadian pensioners, including veterans and dependents (1).

The principal features of the additional data provided by these four studies are: (1) The extension of the time period of followup, (2) the additional data available for specific age groups among men, and (3) the inclusion of substantial data on women. In all, the prospective study reports now available are based on more than 108,000 deaths, an increase of about 43,000 deaths over the 65,023 summarized in the 1964 report. About 19,000 of these additional deaths were among women.

## THE NATURE OF THIS REPORT

This report which provides a summary of current information on the health consequences of smoking, is based on the review of the research reports which have become available since the study of the Surgeon General's Advisory Committee was released. Public Health Service staff members consulted the literature and requested additional information or interpretations of the published data from the research scientists when needed. During this review a complete bibliography, containing some 5,700 citations, was compiled; it is now in manuscript form and will be published shortly (19).

The advice and comments of experts within the Public Health Service, particularly the Bureau of Disease Prevention and Environmental Control and the National Institutes of Health, as well as of specialists outside the Public Health Service, were solicited especially on matters involving judgment and evaluation.

The general criteria used by the Surgeon General's Committee have been followed. First, epidemiological data were evaluated to determine whether an association exists. In judging the significance of the association, its consistency, strength, specificity, temporal relationship, and coherence were utilized. The convergence of evidence from animal experiments, clinical and autopsy studies, and population studies remains the essential basis for evaluation of the significance of the associations identified.

This report presents, under the following headings, the major findings of research studies published in the past 3 to 4 years:

1. Smoking and Overall Mortality.
2. Smoking and Overall Morbidity.
3. Smoking and Cardiovascular Diseases.
4. Smoking and Chronic Bronchopulmonary Diseases (Non-neoplastic).
5. Smoking and Cancer.
6. Other Conditions and Research Areas.

Each of these sections is introduced by pertinent conclusions from the Surgeon General's 1964 Report, which are followed by discussion and conclusions of the present study.

# Smoking and Overall Mortality

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## CONCLUSIONS OF THE SURGEON GENERAL'S 1964 REPORT

CIGARETTE smoking is associated with a 70-percent increase in the age-specific death rates of males, and to a lesser extent with increased death rates of females. The total number of excess deaths causally related to cigarette smoking in the U.S. population cannot be accurately estimated. In view of the continuing and mounting evidence from many sources, it is the judgment of the Committee that cigarette smoking contributes substantially to mortality from certain specific diseases and to the overall death rate.

In general, the greater the number of cigarettes smoked daily, the higher the death rate. For men who smoke fewer than 10 cigarettes a day, according to the seven prospective studies, the death rate from all causes is about 40 percent higher than for nonsmokers. For those who smoke from 10 to 19 cigarettes a day, it is about 70 percent higher than for nonsmokers; for those who smoke 20 to 39 a day, 90 percent higher; and for those who smoke 40 or more, it is 120 percent higher.

Cigarette smokers who stopped smoking before enrolling in the seven studies have a death rate about 40 percent higher than nonsmokers, as against 70 percent higher for current cigarette smokers. Men who began smoking before age 20 have a substantially higher death rate than those who began after age 25. Compared with nonsmokers, the mortality risk of cigarette smokers, after adjustments for differences in age, increases with duration of smoking (number of years), and is higher in those who stopped after age 55 than for those who stopped at an earlier age.

In two studies which recorded the degree of inhalation, the mortality ratio for a given amount of smoking was greater for inhalers than for noninhalers.

The ratio of death rates of smokers to that of nonsmokers is highest at the earlier ages (40-50) represented in these studies, and declines with increasing age.

Possible relationships of death rates to other forms of tobacco use were also investigated \* \* \*. The death rates for men smoking less than 5 cigars a day are about the same as for nonsmokers. For men smoking more than 5 cigars daily, death rates are slightly higher. There is some indication that these higher death rates occur primarily in men who have been smoking more than 30 years and who inhale the smoke to some degree. The death rates for pipe smokers are little if at all higher than for nonsmokers, even for men who smoke 10 or more pipefuls a day and for men who have smoked pipes more than 30 years.

## CURRENT INFORMATION, 1967

The primary addition to knowledge in the areas of smoking and overall mortality comes from the four major population studies. Additional periods of followup have provided a broader base from which it becomes possible to estimate the excess deaths related to cigarette smoking in the U.S. population and from which firmer conclusions may be drawn as to the role of various exposure factors in the associations found.

The contributions since 1964 of each of the four population studies to the relation of smoking and overall mortality, as summarized by the authors, are set forth below.

### STUDY OF U.S. VETERANS

(An 8½ year followup of 293,658 persons holding U.S. Government life insurance policies. Commonly referred to as the Dorn Study after the late Dr. Harold F. Dorn. The most recent report is by Kahn (13).)

"\* \* \* the increased mortality risk associated with cigarette smoking was found to be higher in the more recent calendar time period than in the initial years of the study.

"\* \* \* mortality ratios of current cigarette smokers compared with those who have never smoked are 1.7 for death from all causes, 10.9 for lung cancer, 12.2 for emphysema without bronchitis, and 1.6 for coronary heart disease. Paralysis agitans was the only cause of death associated with significantly lower mortality for smokers than for nonsmokers.

"For all categories of current smokers, risk was related to amount smoked. The risk for cigarette smokers was much greater than that for pipe or cigar smokers. Current smokers of cigarettes, cigars, or pipes experienced a mortality risk significantly greater than that for nonsmokers if they smoked more than four pipes or four cigars daily or more than an occasional cigarette.

"There was a positive relationship between duration of cigarette smoking and mortality risk from all causes of death for at least some classifications of smokers.

"\* \* \* probabilities of death for ex-smokers of cigarettes revealed a downward trend in risk as duration of time discontinued increased, when other variables—age began smoking, amount smoked, and current age—were controlled \* \* \*. The data can be regarded as evidence against the constitutional hypothesis."

Calculations are presented to note that observations made during the study suggest the possibility that data from respondents (those who answered the smoking questionnaire) may in fact underestimate

the risk associated with smoking. The Surgeon General's 1964 Report had considered the possibility that differences between respondents and nonrespondents to the questionnaire might have introduced a bias and had attempted to calculate a maximum estimate of that bias.

#### STUDY OF MEN AND WOMEN IN 25 STATES

(This report is based on 3,764,571 person-years of experience and 43,221 deaths occurring among 1,003,229 subjects—440,558 men and 562,671 women—between the ages of 35 and 84 from October 1, 1959, to February 15, 1960, when they enrolled in a prospective study and answered detailed questionnaires including questions on their smoking habits. Hammond. (11).)

"Death rates of both men and women were higher among subjects with a history of cigarette smoking than among those who never smoked regularly.

"Death rates of current cigarette smokers increased with number of cigarettes smoked per day and degree of inhalation.

"Death rates were higher among current cigarette smokers starting the habit at a young age than among those starting the habit later in life. Among both men and women, the difference between the death rates of cigarette smokers and nonsmokers increased with age.

"Among men, the death rates for ex-cigarette smokers were lower than for men currently smoking cigarettes when they enrolled in the study. Death rates of ex-cigarette smokers decreased with the length of time since they last smoked cigarettes.

"\* \* \* Total death rates and death rates from most of the common diseases occurring in both sexes were higher in men than women, were higher in men who never smoked regularly than in women who never smoked regularly, and were far higher in men with a history of cigarette smoking than in women with a history of regular cigarette smoking.

"The difference between the death rates of subjects with a history of cigarette smoking and subjects who never smoked regularly was far greater among men than women. Female cigarette smokers (as a group) have been far less exposed to cigarette smoke than male cigarette smokers of the same ages, as judged by number of cigarettes smoked per day, degree of inhalation, and the number of years they have smoked. Many female cigarette smokers smoke only a few cigarettes a day, do not inhale, and have been smoking for only a few years; their death rates are about the same as the death rates of women who never smoked regularly."

#### STUDY OF BRITISH PHYSICIANS

(The mortality of nearly 41,000 men and women in the medical profession in the United Kingdom has been followed for 12 years. During the



first 10 years 4,597 of the men and 366 of the women died. These deaths were analyzed in relation to smoking habits reported by doctors in reply to a questionnaire sent to them in 1951—both sexes—and again in 1967, men, and 1960, women. Doll and Hill (8, 9).)

“\* \* \* An association with smoking is found, in differing degrees, in men for seven causes of death [which accounted for 39 percent of the death rate]—namely, cancer of the lung, cancers of the upper respiratory and digestive tracts, chronic bronchitis, pulmonary tuberculosis, coronary disease without hypertension, peptic ulcer, and cirrhosis of the liver and alcoholism. No association is found with the remaining 61 percent of the death rate, and this includes such major causes as other forms of cancer, cerebrovascular accidents, hypertension, myocardial degeneration, suicide, and accidents.

“In women, the few deaths at present available show an association only between smoking and cancer of the lung.

“\* \* \* If the excess deaths in smokers under the age of 65 years from (a) cancer of the lung, (b) chronic bronchitis and emphysema, (c) coronary thrombosis without hypertension be taken as attributable to their cigarette smoking, then the total mortality from all causes at ages 45–64 years is increased thereby by approximately 50 percent.”

The report states: “One of the striking characteristics of British mortality in the last half-century has been the lack of improvement in the death rate of men in middle life. In cigarette smoking may lie one prominent cause.”

#### STUDY OF CANADIAN PENSIONERS

(The purpose of the study was to investigate the relationships between residence, occupation, smoking habits, and mortality from chronic diseases particularly lung cancer. It was initiated by a questionnaire which was sent to Canadian veteran pension recipients during the period September 1955 through June 1956.

Returns from 78,000 men, and 14,000 women, mostly widows, were analyzed. The men were mainly World War I and World War II veterans, but some Boer War and Korean War veterans, as well as some non-veteran pension recipients were included. The age of most of the men at the beginning of the study ranged from 30 to 90 years and the distribution was characterized by the ages of men eligible for service in the two World Wars.

For each respondent dying between July 1, 1956, and June 30, 1962, the cause of death was related to information on his questionnaire about age, history of smoking habits, residence and occupation. Among the respondents during the 6 years of followup there were 9,491 deaths of males, and 1,794 deaths of females which were analyzed (1.)

“Current cigarette smokers had a death rate for overall mortality 54 percent higher than that of nonsmokers \* \* \* Ex-cigarette smok-

ers had a comparatively lower rate, which was still 36 percent above the rate for nonsmokers \* \* \* Men smoking combinations of cigarettes plus cigars and/or pipe also had elevated death rates for overall mortality, but these were not elevated to the same extent as those of men smoking only cigarettes.

"The death rates for overall mortality of pipe smokers and cigar smokers were not appreciably different from those of nonsmokers.

"For cigarette smokers as compared to nonsmokers, overall mortality ratios were elevated after 5 years of smoking at any time in their life and remained elevated as long as they continued to smoke cigarettes.

"Male current cigarette smokers who inhaled had a death rate for overall mortality 52 percent higher than that of those who did not inhale.

"An urban/rural comparison was made between males of equivalent cigarette smoking habits and nonsmokers. It was found that the death rate for overall mortality of urban dwellers (persons with a history of 5 years or more of city residence) was 12 percent higher than that for rural dwellers of comparable smoking habits.

"Respondents were classified into occupational groups based on their history of occupation. No evidence was found in this study of clear-cut associations between cause of death and occupation. Further, occupation did not appear to modify the established association of cigarette smokers with death rates in excess of those of nonsmokers."

## SOME GENERAL CONSIDERATIONS

The problem of how best to measure the relationship between smoking and mortality has been discussed in the Surgeon General's 1964 Report as well as in some of the prospective study reports. As the amount of data available increases, the person-years of observations in the many population subgroups that are worth examining increases so that stable rates may be computed and compared. A brief discussion of three measures of comparison available and their utility seems desirable as confusion frequently arises over these measures.

1. Mortality Ratios: Obtained by dividing the death rate for a classification of smokers by the death rate of a comparable group of nonsmokers.

2. Differences in Mortality Rates: Obtained by subtracting from the death rate for smokers, the death rate of a comparable group of nonsmokers.

3. Excess Deaths: Obtained by subtracting from the number of deaths occurring in a group of smokers, the number of deaths

which would have occurred if that group of smokers had experienced the same mortality rates as a comparable group of nonsmokers. In the example which follows this has been reported as a percentage of all deaths in the appropriate age group.

Table 1 presents in summary form all three measures for five age groups of men from both the U.S. veterans study and Hammond's study and for the same age groups of women from the latter study.

The statistics were derived from the cited publications to provide reasonable comparability and may vary slightly from the figures combined in other ways. Also it should be noted that the age groups are not defined identically and the experience reported covers somewhat different time periods. The smoking group analyzed is "current cigarette smokers," i.e., those who were smoking at the time of enrollment into the study, and the comparison group is "never smoked regularly," i.e., those who had never been regular smokers of any form of tobacco.

The number of deaths in each age-sex group is given to indicate the relative stability of the figures in that column. The data in the veterans study are largely concentrated in age groups 55-64 and 65-74. In Hammond's study, age group 35-44 is less stable than the succeeding groups both for men and for women.

1. *Mortality Ratios.*—For men, these are at their highest in age group 45-54, diminishing in each subsequent decade. In both studies mortality ratios appear to be somewhat lower in the preceding decade 35-44. However, with the smaller numbers of cases available in that age group, it may be that selective factors contribute to the finding. For women the mortality ratios are much smaller than for men, although the same pattern is suggested. In general, a mortality ratio has been considered to reflect the degree to which a classification variable identifies or may account for variations in death rates. As such, it is a measure of relative risk which indicates the importance of that variable relative to uncontrolled variables—an indicator of *potential biological significance*.

2. *Differences in Mortality Rates.*—These increase consistently with increasing age in all three study groups, except for the oldest age group in women where there is practically no difference in the rates for smokers and nonsmokers. Differences between smokers' rates and nonsmokers' rates are much smaller for women than for men, as are the death rates themselves for men and women classified similarly with respect to smoking. This measure reflects the added probability of death in a 1-year period for the smoker over that for the nonsmoker. As such it is a measure of *personal health significance*, a means for the individual to estimate the added risk to which he is exposed.

TABLE 1.—*Comparison of 3 measures of relationship between cigarette smoking and overall death rates by age and sex as derived from 2 major prospective studies (11, 13)*<sup>1</sup>

	Age				
	35-44	45-54	55-64	65-74	75-84
<b>U.S. VETERANS: MEN</b>					
Total deaths.....	383	366	13, 840	17, 550	1, 932
Death rates per 100,000:					
Never smoked regularly.....	127	264	1, 056	2, 411	6, 214
Current cigarette smokers.....	232	728	1, 819	4, 032	8, 471
Mortality ratio <sup>2</sup> .....	1. 83	2. 76	1. 72	1. 67	1. 36
Difference in death rates per 100,000 <sup>3</sup> .....	105	464	763	1, 621	2, 257
Excess deaths as percentage of total <sup>4</sup> .....	33	43	21	17	8
<b>HAMMOND MEN</b>					
Total deaths.....	631	5, 297	8, 427	8, 125	3, 968
Death rates per 100,000:					
Never smoked regularly.....	210	406	1, 202	3, 168	7, 863
Current cigarette smokers.....	397	925	2, 202	4, 788	9, 674
Mortality ratio <sup>2</sup> .....	1. 89	2. 28	1. 83	1. 51	1. 23
Difference in death rates per 100,000 <sup>3</sup> .....	187	519	1, 000	1, 620	1, 811
Excess deaths as percentage of total <sup>4</sup> .....	33	38	25	13	4
<b>HAMMOND WOMEN</b>					
Total deaths.....	727	2, 826	3, 915	5, 115	4, 188
Death rates per 100,000:					
Never smoked regularly.....	165	304	698	1, 913	5, 914
Current cigarette smokers.....	186	384	838	2, 229	5, 846
Mortality ratio <sup>2</sup> .....	1. 13	1. 26	1. 20	1. 17	. 99
Difference in death rates per 100,000 <sup>3</sup> .....	21	80	140	316	68
Excess deaths as percentage of total <sup>4</sup> .....	5	9	4	2	-----

<sup>1</sup> These figures are derived from the references. 5 year age groups were combined directly from the reported statistics without adjustment to any standard population.

<sup>2</sup> Mortality ratios—Death rate for current cigarette smokers divided by death rate for those who never smoked regularly.

<sup>3</sup> Difference in death rates—Death rate for current cigarette smokers minus death rate for those who never smoked regularly.

<sup>4</sup> Excess deaths among current cigarette smokers (i.e., additional deaths that occurred among current cigarette smokers per year above those which would have occurred if smokers had the same death rates as those who never smoked regularly). This is expressed as a percentage of all deaths occurring in that age-sex group.

3. *Excess Deaths as a Percentage of Total Deaths*—As with mortality ratios, this statistic appears to be highest in the age group 45–54 where it reaches 43 percent in one group of men and 38 percent in the other. Hammond's data by 5-year age groups show the highest rate at ages 45–49, where it is 44 percent. Reviewing both study groups it appears that for men between the ages of 35 and 60 approximately one-third of all deaths that occur are excess deaths in the sense that they would not have occurred as early as they did if cigarette smokers had the same death rates as the nonsmoking group. For women, the percentage is much lower, reaching a peak of 9 percent of all deaths in age group 45–54. It should be noted that this measure not only depends on the differences in death rates between the smokers and the nonsmokers, but also on the proportion of smokers in the group. Thus, even with a large difference in rates between smokers and nonsmokers, a population with very few smokers would have very few excess deaths. This measure is therefore an indicator of the *public health significance* of the differences found since it measures the number of people affected and therefore the magnitude of the problem for society as a whole.

Once the magnitude of the excess is identified the problem becomes one of determining (1) how much of the excess would not have occurred if it had not been for cigarette smoking and (2) how much would have occurred anyhow. It should be noted that much of the excess has already been identified as belonging in the first category. Of the remainder, little of the excess has been clearly identified as belonging in the second category—that is, not caused by smoking. With most of that remainder there is uncertainty as to the category in which it belongs.

#### MEASURES OF EXPOSURE

Studies involving smoking, whether epidemiological or behavioral, have been concerned with measures of exposure to tobacco smoke. For the most part, these studies have been restricted principally to the index of number of cigarettes smoked over a specified period of time, usually an "average day." The heavy reliance on numbers of cigarettes alone as a measure has produced important findings but it has possibly obscured others. The new reports on the prospective studies have provided a substantial amount of data to support the concept that many elements should enter into an overall measure of exposure. Such factors as age at beginning smoking, duration of smoking, and inhalation have all shown some independent contributions to the overall effect, along with numbers of cigarettes. A recent report (12) has attempted to develop a more adequate measure of exposure in which various individual components of dosage would be combined to form composite scores.

A dosage score was developed as a function of the average number of cigarettes smoked per day, the "tar" (smoke solids minus moisture) rating of the brand of cigarette smoked, and the portion of the cigarette actually smoked. In addition, questions on both depth and frequency of inhalation were developed. Normative data have been obtained from a national survey sample of smokers. In general, although the various measures reflecting exposure are interrelated, there are many individuals with high exposure on one measure but low exposure on another. Furthermore, there are systematic differences in some of these measures of dosage between men and women, between heavy and light smokers (by the usual criterion of numbers of cigarettes), etc. The existence of a dose-response relationship between exposure to cigarette smoke and the risks most clearly associated with cigarette smoking is now generally accepted.

Wynder and Hoffmann (20) have shown in laboratory experiments with animals that the tumorigenicity of cigarette smoke can be reduced by alteration in the cigarette which reduces the "tar" and nicotine content. They use the term "indicator" for "tar" and nicotine content (the two measures tend to be used jointly since when one is high the other tends to be high unless the nicotine has been removed in processing), or other measures which reflect this type of relationship, lacking the identification of specific agents which are responsible for the effect. Bock, Moore, and Clark (2) have independently shown a similar variation in carcinogenic activity of tobacco "tar" obtained from different types of cigarettes.

The preponderance of scientific evidence strongly suggests that the "tar" and nicotine content of cigarette smoke is a meaningful factor in the measurement of dosage.

#### CESSATION OF SMOKING

The cessation of smoking is, of course, an extreme example of the reduction of dosage. Data from the prospective studies show a reduction in both overall mortality and mortality from specific diseases among those who have stopped smoking when compared with those persons who continue to smoke. This finding has been somewhat obscured by the fact that ill health is a frequent cause of giving up smoking so that death rates and disability rates for ex-smokers as a group tend to be high for an initial period of time following cessation.

In this connection, the Study of British Physicians shows that among the total group of physicians in the study (smokers, ex-smokers, and those who never smoked, combined) there was a reduction in the standardized lung cancer death rate from 0.69 per 1,000 in the first 5 years of the study (1951-56) to 0.64 per 1,000 in the second 5 years of the study (1956-61). This reduction occurred during

the time when there was also a substantial drop in cigarette smoking among physicians in general, and during the time that lung cancer rates were rising in the male population of Great Britain. This situation is not unlike that of a controlled cessation experiment in which the effect of giving up smoking is judged by the mortality results in an entire population in which the giving up of smoking is common as against another population in which it is not common. A more recent report by Doll (7) suggests that this trend is becoming more marked as the rate of smoking among British physicians decreases and the length of the cessation period increases.

These findings are shown in Table 2, which has been derived from Doll's report (7). The lung cancer death rate among men in England and Wales increased from 1.49 per 1,000 in the period 1954-57 to 1.86 per 1,000 in the period 1962-64, a rise of 25 percent. At the same time, the lung cancer death rate for British physicians dropped from 1.09 per 1,000 in the first period to 0.76 per 1,000 in the second period, a reduction of 30 percent. This reduction in death rates from lung cancer among all physicians is larger than would have been anticipated from examining only the experience of those physicians who had stopped smoking before the study began and indicates that the experience of ex-smokers in prospective studies probably understates the benefits of giving up smoking.

With these findings the case for cigarette smoking as the principal cause of lung cancer is overwhelming. The reduction of rates experienced in ex-smokers as compared with continuing smokers is clearly shown in the case of lung cancer to be a reflection of a significant change in risk. Since the concern that selective bias might have accounted for the earlier findings has been contraindicated, a stronger case can now be made for interpreting reduced rates of overall mortality for those who give up smoking as also reflecting a direct alteration of risk compared to those who continue to smoke.

There are no adequate data to evaluate the benefit of reductions in exposure that are more modest than those achieved by complete cessation, although it seems reasonable to assume that a substantial reduction in exposure is likely to be accompanied by some reduction in risk relative to those who do not reduce their exposure.

TABLE 2.—*Changes in the lung cancer death rate in male British physicians (age 35–84) compared with changes in the rates for the male population of England and Wales for 3 time intervals between 1954 and 1964 (7)*

Time period	Lung cancer death rates per 1,000 per year	
	Men in England and Wales	British physicians
1954 to 1957.....	1.49	1.09
1958 to 1961.....	1.71	.83
1962 to 1964.....	1.86	.76
Percentage change:		
1st to 2nd period.....	+15	–24
2nd to 3rd period.....	+9	–8
1st to 3rd period.....	+25	–30



## Smoking and Overall Morbidity

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AT THE TIME of the Surgeon General's 1964 Report there was no information available on the overall disability associated with smoking. To investigate the relationship between smoking and morbidity, the National Center for Health Statistics of the Public Health Service introduced questions about cigarette smoking into its National Health Survey, beginning in July 1964. This Survey is a continuing study conducted since 1957.

In carrying on this Survey, interviewers each year visit 42,000 families (selected as a probability sample of the civilian, noninstitutional population of the United States) and question them about illness, disability, and days absent from work because of illness, as well as the nature of the illness. In the year ending in June 1965, they inquired (after all other questions about health had been asked) about the smoking habits of persons in the family who were 17 years of age or over.

The National Health Survey is concerned with three overall measures of the impact of illness.

1. *Days Lost From Work.*—These are days absent from job or business because of illness or injury. They apply only to those persons who are currently employed and are therefore heavily concentrated in age groups 17-64.

2. *Bed Days.*—These are days when the person is sufficiently ill or disabled so as to spend all or most of the day in bed, either at home or in a hospital. All days spent as a hospital patient are included.

3. *Days of Restricted Activity.*—These are days when a person cuts down his usual activities for most of a day because of an illness or an injury. Days lost from work because of illness and bed days are, of course, counted as days of restricted activity. This represents the most general measure of disability available in the United States today.

Table 3 summarizes the findings in a form similar to that used for summarizing the overall mortality utilizing three measures of morbidity effect: Morbidity ratios, differences in rates, and excess days of disability.

TABLE 3.—Comparison of 3 measures of relationship between cigarette smoking and 3 types of disability days by age and sex as derived from the National Health Survey (16)

	Male			Female		
	17-44	45-64	65 and over	17-44	45-64	65 and over
<b>WORK-LOSS DAYS</b>						
Estimated total days (millions)-----	112	127	21	80	55	4
Rate: <sup>1</sup>						
Never smoked cigarettes-----	3.4	5.6	9.8	4.5	5.3	5.0
History of cigarette smoking----	4.4	8.5	9.8	6.5	6.9	(?)
Morbidity ratio <sup>2</sup> -----	1.3	1.5	1.0	1.4	1.3	(?)
Difference in morbidity rates <sup>1 4</sup> ----	1.0	2.9	0	2.0	1.6	(?)
Excess days as percentage of total <sup>5</sup> —	20	28	0	18	11	(?)
<b>RESTRICTED ACTIVITY DAYS</b>						
Estimated total days (millions)-----	305	386	271	543	469	395
Rate: <sup>1</sup>						
Never smoked cigarettes-----	7.5	15.0	32.9	13.3	22.6	40.1
History of cigarette smoking----	10.6	22.9	37.9	17.8	25.3	44.8
Morbidity ratio <sup>2</sup> -----	1.4	1.5	1.2	1.3	1.1	1.1
Difference in morbidity rates <sup>1 4</sup> ----	3.1	7.9	5.0	4.5	2.7	4.7
Excess days as percentage of total <sup>5</sup> —	23	28	8	14	5	2
<b>BED DAYS</b>						
Estimated total days (millions)-----	111	118	100	210	168	146
Rate: <sup>1</sup>						
Never smoked cigarettes-----	2.7	4.6	13.4	5.4	8.0	15.1
History of cigarette smoking----	3.9	6.9	13.0	6.7	9.2	15.2
Morbidity ratio <sup>2</sup> -----	1.4	1.5	.97	1.2	1.1	1.0
Difference in morbidity rates <sup>1 4</sup> ----	1.2	2.3	-0.4	1.3	1.2	0.1
Excess days as percentage of total <sup>5</sup> —	23	28	-1	10	6	0

<sup>1</sup> Rate is defined as "days per person per year."

<sup>2</sup> Based on too few smokers for stable rates.

<sup>3</sup> Morbidity Ratios—Morbidity rate for cigarette smokers divided by morbidity rate for those who never smoked cigarettes.

<sup>4</sup> Difference in Morbidity Rates—Morbidity rate for cigarette smokers minus morbidity rate for those who never smoked cigarettes.

<sup>5</sup> Excess deaths among cigarette smokers (i.e., additional days of disability that occur among cigarette smokers per year above those which would have occurred if smokers had the same rates as those who never smoked cigarettes). This is expressed as a percentage of all disability days occurring in that age-sex group.

#### DAYS LOST FROM WORK

For those with a history of cigarette smoking, classified by heaviest amount smoked, the average number of days was 7 percent higher for men and 15 percent higher for women who had smoked less than 11 cigarettes per day; 33 percent higher for men and 60 percent higher

for women who had smoked 11-20 cigarettes per day; 48 percent higher for men and 79 percent higher for women who had smoked 21-40 cigarettes per day; and 83 percent higher for men and 140 percent higher for women who had smoked more than 40 cigarettes per day. The relationships expressed by all three measures are somewhat higher among men aged 45-64 than among men aged 17-44, but lower among women aged 45-64 than among women aged 17-44. In the survey year, there were an estimated 399 million workdays lost in the United States because of illness. A total of 77 million days, or 19 percent, were excess workdays lost because of the higher rates which exist among persons who have ever smoked cigarettes as compared to those who never smoked. This excess loss is highest in men 45-64 where it represents 28 percent of all days lost.

#### BED DAYS

For those with a history of cigarette smoking, classified by heaviest amount smoked, the average number of days was 10 percent higher for men and 4 percent lower for women who had smoked less than 11 cigarettes per day; 22 percent higher for men and 17 percent higher for women who had smoked 11-20 cigarettes per day; 22 percent higher for men and 57 percent higher for women who had smoked 21-40 cigarettes per day; and 53 percent higher for men and 192 percent higher for women who had smoked more than 40 cigarettes per day. Relationships with smoking are higher for men than for women for all three measures except for age 17-44 in which the differences in morbidity rates between smokers and nonsmokers are about the same. For the entire population 17 years of age and older there were an estimated 853 million bed-days in the survey year. A total of 88 million of these days, or 10 percent, were "excess" days lost because of the higher rates which exist among persons who have ever smoked cigarettes as compared to those who never smoked. Excess days as a percentage of total bed-days is highest for men aged 45-64, where it is 28 percent.

#### DAYS OF RESTRICTED ACTIVITY

For those with a history of cigarette smoking classified by heaviest amount smoked, the average number of days was 12 percent higher for men and 4 percent higher for women who had smoked less than 11 cigarettes per day; 32 percent higher for men and 22 percent for women who had smoked 11-20 cigarettes per day; 39 percent higher for men and 48 percent higher for women who had smoked 21-40 cigarettes per day; and 81 percent higher for men and 146 percent higher for women who had smoked more than 40 cigarettes per day. Again rates are higher for men than for women in all three measures except for age group 17-44, in which differences in morbidity rates are higher for women. There were an estimated 2,369 million such days

in the survey year; 306 million, or 13 percent, were excess days lost because of the higher rates which exist among persons who have ever smoked cigarettes as compared to those who never smoked. Excess days as a percentage total restricted activity days was highest in men aged 45-64.

To help evaluate these general indices of morbidity as measured by various kinds of disability days it is necessary to turn to the conditions which are reported more frequently by cigarette smokers than by non-smokers. Since these are either self-reports or reports made by a responsible member of the household for others in the household, the diagnostic accuracy of the reports is obviously less than one could obtain from direct medical examination. Nevertheless, the bulk of the reports on chronic conditions reflect what a physician has previously told the patient or the family with regard to a diagnosis of the condition.

Chronic conditions (one or more) are reported by 11 percent more of the men and 9 percent more of the women who have ever smoked cigarettes than by those who have never smoked cigarettes. This is especially high in those who have reported their highest consumption rate to have been over two packs a day (32 percent higher for men and 43 percent higher for women). At the lower levels of consumption the rates reported are 21 percent and 25 percent higher for those smoking 21-40 cigarettes per day, but only 6 percent higher for men and 7 percent higher for women for those smoking 11-20 cigarettes per day and only 1 percent higher for both men and women who have never smoked more than 10 cigarettes per day. The differences are especially marked among present smokers of more than two packs per day whose rate of reporting three or more chronic conditions is 73 percent higher for men and 143 percent higher for women than for those who have never smoked cigarettes.

Applying differences in prevalence rates to the entire U.S. population 17 years of age and over yields the estimate that there are approximately 11 million more cases of chronic illness annually than there would be if all people had the same rate of sickness as those who had never smoked cigarettes. A large portion of these are accounted for by conditions classified as "chronic bronchitis and emphysema," "heart conditions," "peptic ulcers," and "sinusitis." All but the last of these have previously shown substantially higher mortality rates among cigarette smokers. Sinusitis, being a nonfatal condition, has not been identified in the studies of mortality previously reported. The "heart condition" relationship is most marked in the category "arteriosclerotic heart disease including coronary disease."

The age-adjusted incidence rate of acute conditions for persons who had ever smoked was 14 percent higher among men and 21 percent higher among women than the rates for "never smokers." However,

particular caution must be taken in interpreting the results relating specific acute conditions to cigarette smoking because of the relatively large sampling error connected with the estimates for the several types of acute conditions.

Since the National Health Survey is not a prospective study, it does not identify the rate at which various types of morbidity develop in comparable groups of smokers and nonsmokers, but reports the recent existence of such disability. Therefore, the findings are much more significant when they support relationships previously identified than when new relationships are identified. It should not be surprising that causes of mortality which are associated with cigarette smoking have a counterpart in disease or disability associated with smoking.

As the primary source of data in the United States on disability, the Survey report, being based on a national probability sample, provides a solid base for estimating the excess overall disability associated with cigarette smoking.

### HIGHLIGHTS OF CURRENT INFORMATION ON OVERALL MORTALITY AND MORBIDITY

1. The previous conclusions with respect to the association between smoking and mortality are both confirmed and strengthened by the recent reports. The added period of followup and analysis of deaths of nonrespondents as well as of respondents in the Dorn Study suggests that the earlier reports may have understated the relationship.

2. More information is now available for specific age groups than previously. A comparison of three ways of measuring the relationship indicates that cigarette smoking is most important among men aged 45 to 54 both in terms of mortality ratios and excess deaths expressed as a percentage of total deaths. Nevertheless, although both of these measures decline with advancing age, the increment added to the death rate, which reflects one's personal chances of being affected, continues to increase with age. For men between the ages of 35 and 59, the excess deaths among current cigarette smokers account for one out of every three deaths at these ages. For women, with their lower overall exposure to cigarettes, the comparable figure is about one death out of every 14 at ages 35 to 59.

3. Women who smoke cigarettes show significantly elevated death rates over those who have never smoked regularly. The magnitude of the relationship varies with several measures of dosage. By and large the same overall relationships between smoking and mortality are observed for women as had previously been reported for men, but at a lower level. Not only are the death rates for men who have never smoked regularly higher than those for women who have never smoked

regularly, but the effect of smoking as measured either by differences in death rates or by mortality ratios is greater for men than for women. At least part of this can be accounted for by the lower exposure of female cigarette smokers whether measured by number of cigarettes, duration of smoking, or degree of inhalation.

4. Previous findings on the lower death rates among those who have discontinued cigarette smoking are confirmed and strengthened by the additional data reviewed. Kahn's analysis of ex-smokers in the U.S. veterans study—controlling for age at which they began smoking, amount smoked, and current age—reveals a downward trend in risk relative to those who continued to smoke as the duration of time discontinued increases. The British physician study, in which a downward trend is reported in lung cancer death rates for the entire group (smokers, ex-smokers, and those who never smoked, combined) along with a very sharp reduction in cigarette smoking by the physicians, is the best available example of a controlled cessation experiment with reduction of risks resulting from reduction of smoking. The findings of this report support the view that epidemiological data showing lower death rates among former smokers than among continuing smokers cannot be dismissed as due to selective bias and that the benefits of giving up smoking have probably been understated.

5. Cigarette smokers have higher rates of disability than non-smokers, whether measured by days lost from work among the employed population, by days spent ill in bed, or by the most general measure—days of "restricted activity" due to illness or injury. Data from the National Health Survey provide a base for estimating that in 1 year in the United States an additional 77 million man-days were lost from work, an additional 88 million man-days were spent ill in bed, and an additional 306 million man-days of restricted activity were experienced because cigarette smokers have higher disability rates than nonsmokers. For men age 45 to 64, 28 percent of the disability days experienced represent the excess associated with cigarette smoking.

# Smoking and Cardiovascular Diseases

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## CONCLUSIONS OF THE SURGEON GENERAL'S 1964 REPORT

Male cigarette smokers have a higher death rate from coronary artery disease than nonsmoking males, but it is not clear that the association has causal significance.

## CURRENT INFORMATION, 1967

Important additional epidemiological information from five prospective mortality studies confirms that cigarette smokers have substantially higher death rates from coronary heart disease than do nonsmokers. This is true for both men and women although the relationships are less marked in women. Cigarette smoking also markedly increases an individual's susceptibility to earlier death from coronary disease. In general, mortality rates increase with increasing amounts smoked.

Cessation of cigarette smoking is followed by a reduction in the risk of coronary heart disease mortality relative to those who continued to smoke. Epidemiological evidence indicates that there is little risk of coronary heart disease associated with cigar and/or pipe smoking.

The Surgeon General's 1964 Report indicated a median mortality ratio of 1.7 for current cigarette smokers, with a range from 1.5 to 2.0. Additional evidence from the Hammond study (11) indicates that young smokers between the ages of 45 and 54 have the highest mortality ratios—three times as great for men, and twice as great for women if they smoke 10 or more cigarettes per day, as compared with nonsmokers. In general, the mortality ratio shows the most marked increases with increasing amount smoked for the ages under 65. While the cigarette smokers older than 65 have lower mortality ratios than those under 65, the public health significance of the relationship in the older population is substantial because of the large numbers of people over 65 who die of coronary heart disease. Studies of U.S. veterans (13), Canadian pensioners (1), British physicians (8, 9, 10),